Demand Response Research Center

PIER DEMAND RESPONSE RESEARCH CENTER

Research Opportunity Notice – DRRC RON -02

Incentives and Rate Design for Efficiency and Demand Response

Final July 21 2005

Research Goal

The purpose of this RON is to solicit proposals for research that will develop two key products:

1. Provide a conceptual framework for integrating and improving the effectiveness of incentives used to support efficiency and demand response and
2. Provide prototype rate designs to illustrate the application of the framework for residential, commercial and industrial customers.

Background

Rate designs are a mechanism for pricing energy to the customer and correspondingly for collecting the revenue due to the utility. Demand response (DR) incentives provide a corollary function by motivating customers to change energy usage patterns and behavior that in turn should lower total system costs for all customers.

Historical Perspective – Rates and Demand Response

Starting in the late 1800's, incentive-based rate designs were commonly employed by electric utilities to build load and promote competitive positioning against other energy providers. Demand building (demand response) programs were considered an expected and normal part of the business process, a tool for building a more efficient resource mix, providing enhanced customer services and for competing with other service providers. In the 1950's, "Reddy Kilowatt " and then later in the 1960's, the "Live Better Electrically" (LBE) program of the Edison Electric Institute [1] became popular electric industry advertising and programmatic vehicles for encouraging greater electricity use. According to one report "..the EEI directors considered that the profit potential available from the successful stimulation of demand would warrant full cooperation of investor-owned utilities in the LBE program".[2] Throughout this period and until the passage of PURPA[3] in 1978, industry prevailing declining block rates rewarded customers by providing lower unit costs with increased electricity usage. Declining block rates reflected the declining costs and economies of scale arising from the implementation of large central generating stations. The incentives to consume more were presented to the customer in a rate that was easy to understand.

In 1978, PURPA replaced declining block and related rates that encouraged greater electricity consumption with inverted tier and time-of-use rates to encourage conservation and efficiency. In the years since 1978, retail rates have become increasingly complex with a variety of adders

[1] "Live Better Electrically Program", Problems in Marketing, McGraw-Hill, 1965, Case material of the Harvard Graduate School of Business Administration.

[2] Ibid.

[3] Public Utility Regulatory Policies Act of 1978 (PURPA) A US federal law enacted in 1978.

and adjustments to accommodate lifeline, conservation, public goods charges, and demand and revenue stabilization objectives.

The passage of PURPA and the changing economics of power production changed almost 80 years of demand response focused on load building to demand response focused on peak reduction and load shifting. Because these new DR efforts were uncertain and untested, utilities separated DR incentives from basic retail rates, preferring instead to pay for DR program participation rather than tie incentives to actual customer performance. There were practical reasons for this approach. Incorporating DR incentives into the underlying rate for new programs that were not widely accepted or proven could be costly, requiring revised rate designs, regulatory proceedings and public hearings. Performance based rates also would necessitate advanced metering and communication systems to capture the appropriate billing metrics and changes in the customer load profile. Because participation incentives were less expensive to administer than advanced meters, they prevailed and have since become the default industry standard for small customers. Electric utilities also prefer direct load control programs . because the load response is considered more reliable and predictable. There is less experience with price-response programs that require end-use customers to respond to dynamic electricity prices.

While advanced metering to support interruptible rates and other performance-based tariffs for large commercial and industrial customers has been easier to cost justify, demand response incentives are still predominantly reflected as adders or discounts to an underlying rate rather than a redesign of the basic rate. The difficulties in redesigning the basic rate are often attributed to conflicting revenue collection, revenue stability and historical approaches to rate design. These problems were outlined in a recent CPUC action on Critical Peak Pricing (CPP) for large commercial industrial customers. Formal rate design activities were launched to address these problems.[4]

<u>Rate Design – Myths and Related Demand Response Problems</u>

While separate participation incentives and add-on rate adjustments may have had a logical basis when DR was first introduced, the lack of integration with the customer's basic retail rate is now a major cause for concern. Participation incentives may have value in short-term pilots, however it is not clear that they provide an effective option for long-term, stable option to sustain demand response. Some of the problems include:

1. **DR participation incentives create equity issues**. Rewarding all customers equally for participation in electric load reduction programs regardless of their peak load contribution always over compensates some customers and under compensates others. Incentives tailored to a customer's annual usage reduces but cannot fully correct for this equity problem because even within a strata, end-use usage varies substantially. Paying customers to participate in a DR program because they own a targeted end-use can be considered a reward for creating the problem that justified the DR program in the first

[4] CPUC Proposed Decision of ALJ Cooke, Opinion Addressing Critical Peak Pricing Rates for Customers 200 kilowatts or larger, R.02-06-001, issued March 28, 2005

place. Such payments are a disincentive for those who chose more energy efficient or more environmentally beneficial options.

Figure 1 provides an example of how a fixed participation incentive for a typical air conditioner load control program can distort the capacity value provided to the customer.. Figure 1 also shows how a dynamic critical peak-pricing rate (CPP) that integrates an underlying two-part TOU rate with a dispatchable critical peak price rewards customers based on performance and eliminates inequity conditions with participation payments. The table shows that with a participation incentive, the customer receives an annual $50 participation payment whether they are a low, average, or high-energy user and irrespective of how much actual load they contribute during a control event. The lowest usage group often contributes no demand reduction, which produces an effective incentive in this example that can exceed $1000/kW. With rate-based incentives, the incentive is identical for all customer groups at $0.704/kW. If the low user does not reduce their power during peak times, their incentive is zero. The high user's annual incentive reaches $56/year based on 40 hours of CPP events with the air conditioner cycled off 50% of the time.

Figure 1. Example – Addressing Incentive Equity Through Rate Design[5]

Participation vs. Performance Incentives

Customer Usage Group	Participation Incentive		Rate-Based Incentive	
	Annual Participation Payment	Effective Incentive $/Peak kW	CPPV Effective Incentive $/Peak kW	CPPV Annualized Performance Incentive
Lowest User	$50.00	> $1,000.00	$0.704	$0.000
Low User	$50.00	$31.25	$0.704	$1.13
Average User	$50.00	$3.38	$0.704	$10.14
High User	$50.00	$1.69	$0.704	$20.56
Highest User	$50.00	$0.63	$0.704	$55.76

- $50 annual participation payment
- 40 hours of operation/curtailment per season @ 50% cycle off
- CPPV – critical peak rate $0.704 / kWh

1 2

Which incentive is more equitable ?

[5] Unlocking the Potential for Efficiency and Demand Response Through Advanced Metering, ACEEE 2004 Summer Session, J. Wilson, California Energy Commission; K.Herter, LBNL; R. Levy, Levy Associates.

2. **DR participation payments build in recurring annual utility incentive expense, whether the program is used or not.** Regulators have been increasingly questioning seasonal DR programs that pay customers for doing nothing. [6] Most DR programs focus on peak reduction that is coincident with hot summers and cold winters. Moderate weather conditions often don't require DR programs to be activated. Participation payments based on projected avoided costs still must be paid. Consequently, during moderate weather-years utilities are obligated to pay customers for participating in programs that aren't necessary. The alternative is to operate the program anyway and inconvenience customer unnecessarily.

3. **There is a general perception that inverted tier and TOU rates provide customers with strong 'conservation oriented' incentives.** Preliminary evaluations done in conjunction with the California pilot that compared inverted tier with TOU and critical peak pricing (CPP) show that the time-differentiated rate forms provide substantially greater incentives than inverted tier rates. Figure 2 provides an example that contrasts what a low and high usage customer served by PG&E would have paid based on three different rate forms just for their air conditioner usage during a typical summer month. For each of the three rate examples, the customer's total monthly bill remains unchanged, however the charges and allocation of the monthly bill by time period vary substantially. Given a constant monthly bill, higher incentives for air conditioning with TOU and Critical Peak (CPP) rates imply that off-peak costs are substantially lower than those reflected in the inverted tier rate. What customers pay is a proxy for the incentives they have to either replace their existing appliance with a more efficient unit or to curtail or shift their existing usage. In these examples, CPP pricing provides much greater incentives than either conventional inverted tier or TOU rates. Higher incentives reflect the time varying costs for peak energy. The higher CPP costs provide a clear DR signal and may also improve and accelerate the cost effectiveness justification for higher efficiency air conditioning and increased insulation. In this case, a CPP rate form integrates and improves the potential effectiveness of both efficiency and DR.

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[6] The Minnesota Public Utilities Commission questioned (Docket No. E002/M-01-46) the justification for the Northern States Power "Saver's Switch" air conditioner load control program that paid customers annual incentives even during cool summers that did not require control actions.

Figure 2. Contrasting the Incentive Potential For Various Rate Forms[7]

Operating Incentives vs. Rate Design

Single Day Customer Cost for Air Conditioning

What Does the Customer Pay ?	Inverted Tier (2:00 to 7:00pm)	TOU (2:00 to 7:00pm)	Critical Peak (4:00 to 7:00pm)
Lowest User Pays	$0.92	$1.72	$3.94
Highest User Pays	$5.28	$5.93	$12.14
	1	2	3

Which rate offers the best operating incentive ?

4. **Rates no longer have any relationship to actual energy costs or system conditions**. Many rates do not reflect either the time-varying fluctuations in utility resource costs nor do they reflect reliability impacts of localized congestion in the distribution system.
5. **Rates have become too complex for any customer to understand**. Market research completed for the recently completed Statewide Pricing Pilot concluded that residential and small commercial customers do not understand their existing declining block rates, have no idea what price they pay for electric service, don't understand their monthly bill and as a result have difficulty associating the value they receive from electric service with what they pay.[8]
6. **Rates have been increasingly engineered to preserve and stabilize utility revenue requirements, while providing no incentive for customer demand response.** There are fundamental conceptual and regulatory problems with existing rate design practices that perpetuate customer confusion and limit potential conservation and demand response. For example, the maintenance of revenue neutrality creates a zero sum game that effectively just shifts costs from one group of customers to another. Under revenue neutrality, savings that result from demand reductions or conservation by one group of customers within a class are increase the rates and revenue collected from all remaining customers in that class.

Candidate Research Topics

Each new proposed research project should explore one or more of the following issues:

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[7] IBID No.5

[8] Residential Customer Understanding of Electricity Usage and Billing, Momentum Market Intelligence, California Energy Commission and California Public Utility Commission Working Group 3 Report, January 29, 2004, p16.

1. Examine the impacts of existing rate designs and incentives.
   - Identify incentives and rate forms used to support energy efficiency and DR. Provide examples from existing research and previous evaluations to examine the actual customer bill, utility and peak demand reduction impacts. Consider various rate design elements such as dynamic prices, TOU and flat energy charges, and peak demand charges.
   - Identify alternative incentives and rate forms to support and integrate DR and energy efficiency as well as the potential costs and benefits, policy, procedural and development needs and opportunities with each alternative.
   - Summarize customer, utility, and societal issues linked to current rate and incentive designs. Address related issues including but not limited to utility revenue requirements, principles of welfare economics, reliability, total costs (environmental) and other factors. Explore local reliability issues and location based pricing.
2. Develop new, innovative and more equitable rate and incentive designs.
   - Develop conceptual frameworks for rate designs to support the integration of energy efficiency and DR. Address key issues including fixed versus floating revenue requirement and rates designed to stabilize utility profit. Address customer simplicity and billing needs / requirements. Provide case studies and/or simulations to illustrate tradeoffs and impacts.
   - Identify the policy, equity and other implementation issues associated with preferred rate design options.

Project Requirements

Each project should include the following activities:

1. Incentive and Rate Design Evaluation Framework

This research is intended to help build an analytical framework for current DR tariff analysis, but to also facilitate long term research concerning electricity pricing. Thus, the methodology and analytical framework for the research is a key product or outcome for use in future projects. Consider tradeoffs between simplicity and accuracy.

2. Develop And Execute Project Stakeholder Communications and Outreach Plan

The project must develop and execute a project stakeholder communications and outreach plan to ensure the project is up to date with ongoing CPUC and utility activities concerning dynamic tariffs. Also, the project must develop a plan to communicate ongoing research results back to key stakeholders. Key issues and activities concerning CPP are as follows:

- On March 29, 2005 the California Public Utilities Commission (CPUC) issued a proposed decision (R-02-06-001)[9] addressing critical peak pricing (CPP) rates for customers with demands greater than 200 kW. The CPUC proposed decision delays

[9] CPUC Proposed Decision of ALJ Cooke, Opinion Addressing Critical Peak Pricing Rates for Customers 200 kilowatts or larger, R.02-06-001, issued March 28, 2005.

mandatory implementation of CPP to the summer of 2006 or incorporates implementation into a comprehensive rate design in 2006 or 2007.

- The CPUC decision postponed implementation of mandatory CPP rates to provide more time to address numerous rate design, customer education and implementation problems not fully addressed in the original PG&E, SCE and SDG&E filings. According to the proposed decision, the CPUC remains committed to the development of mandatory CPP rates that send better price signals to all customers. The CPUC is using this proposed decision to lay out the lessons learned from existing implementation efforts and testimony from the current proceeding to provide guidance regarding future rate design efforts, specifically:
  - The rate design approach, event definition, and event triggers, should be as consistent as possible between service territories although the actual rate of each utility may vary based on its different cost structure.
  - What is the best option for sending pricing and investment signals to customers? Some argue that dispatched, infrequent critical peak price signals will maximize customer response while mitigating day-to-day fluctuations in cost while others argue for redesigned three or four-part TOU rates. .
  - Does the conventional revenue requirement structure create equity and incentive barriers that limit the feasibility and effectiveness of DR? Furthermore, what options can be created to address utility revenue requirements while at the same time creating and reflecting realistic incentives for customer DR?
  - How can rate designs be simplified to improve equity and customer understanding? Are different rate design structures necessary to distinguish between types (residential, commercial/industrial) and sizes (high users and low users) of customers or is a common, unified rate design structure feasible?

Summary

Fundamentally, customer conservation, efficiency and demand response capability is limited by their facility characteristics, appliance holdings and certain operating and lifestyle schedules. Once facility characteristics, end-use holdings and usage patterns are established, customers may or may not be capable of supporting all three energy objectives. Better controls and communication systems may create opportunities to motivate load changes locally and address current and emerging reliability concerns. Building and appliance standards and financial incentives to encourage energy efficiency will potentially motivate different building equipment, process controls, and appliance purchases and usage behavior than incentives to encourage demand response. At issue is whether conservation, efficiency and demand response objectives are mutually exclusive or consistent with each other and whether policies, standards and financial incentives designed to support only one objective facilitate or create barriers to achieving the other objectives. There is misunderstanding regarding existing rate design and the impacts on customer usage in general and DR in particular. The perception that existing inverted tier rates encourage conservation and investment in efficiency better than other time-of-use or dynamic critical peak pricing rate options needs to be examined. In addition, the existing incentive structures need to be examined to identify whether they compliment or create barriers to DR.

Acronyms

CEC	California Energy Commission
CPP	Critical Peak Pricing
CPUC	California Public Utilities Commission
DBP	Demand Bidding Program
DR	Demand Response
EEI	Edison Electric Institute
kW	Kilowatt
kWh	Kilowatt hour
LBE	Live Better Electrically
PG&E	Pacific Gas and Electric Company
PURPA	Public Utility Regulatory Policies Act
RON	Research Opportunity Notice
RTP	Real Time Pricing
SCE	Southern California Edison
SDG&E	San Diego Gas and Electric Company
SPM	Standard Practice Methodology
SPP	Statewide Pricing Pilot
TOU	Time of Use

Glossary

California Energy Commission (CEC): A California regulatory agency charge with the authority to site power plants, maintain the Title 24 Building and Appliance Standards, support the development of demand response and provide research on technologies relevant to all of its areas of authority.

California Public Utilities Commission (CPUC):   A California regulatory agency charged with the authority to adopt rates and oversee the performance of investor owned electric utilities, with related authority over water, gas, telephone and other public service entities.

Critical Peak Pricing (CPP): A retail electricity pricing rate on which customers are charged a high price during a limited number of critical peak periods initiated in response to electricity market or system conditions such as wholesale price spikes or supply shortages. Depending on the particular tariff, the critical peak price may either be fixed at a pre-determined level or varied to reflect short-term market or system conditions. Critical peak pricing may be combined either with a standard Time-of-Use rate or a flat rate.

Demand Response (DR): Demand Response includes all intentional modifications to the electric consumption patterns of end-use customers that are intended to modify the timing or quantity (including both the level of instantaneous demand (capacity), and total consumption (in kWh or MWh) of customer demand on the power system.

Edison Electric Institute (EEI): An industry association that represents investor owned electric utilities.

Energy Efficiency: Reducing the energy used by end-use devices and systems while maintaining comparable service, generally achieved by substituting technically more advanced equipment and practices to produce the same level of end-use service with less electricity.

Inverted Block, Inverted Tier Rate: A retail electricity rate on which customers are charged progressively higher flat rates for successive increments of electricity usage in each billing cycle.

Live Better Electrically(LBE): A promotional program started in the 1960's to promote electric usage.

Obligation to Serve: A common law concept that requires regulated electric utilities to provide adequate, affordable and reasonably efficient services to all customers without unjust discrimination.

Public Utilities Regulatory Policies Act (PURPA): Legislation adopted by the US Congress in 1978 to address changes to utility rate design, resource planning and delivery services.

Rate Forms: The combination of charges used to compute the customer utility bill.

Real Time Pricing (RTP) Rate: A retail electricity rate on which customers are charged prices that vary by hour and reflect hourly variations in wholesale electricity prices. Real time pricing tariffs may vary with respect to a number of other options, such as the availability of price hedging options (e.g., price collars) and the components of the electricity service (generation, transmission, and distribution) billed at the hourly rates.

Standard Practice Methodology (SPM): A multi-part cost benefit methodology under jurisdiction of the California Public Utilities Commission (CPUC) used by the CPUC, utilities and program planners to quantify the costs and benefits of conservation and demand response initiatives.

Statewide Pricing Pilot (SPP): A joint pilot program to test the demand response capability of Critical Peak Pricing (CPP) involving 2,500 customers over a two year period (2003-2004) conducted by Pacific Gas & Electric (PG&E), Southern California Edison (SCE) and San Diego Gas & Electric (SDG&E) in conjunction with the California Energy Commission (CEC) and California Public Utilities Commission (CPUC).

Time of Use Rate (TOU): A retail electricity rate on which customers are charged according fixed price tiers that apply to specified times of the day and days of the week.